

11th INPRO Dialog Forum
“INPRO Dialogue Forum on Roadmaps for a Transition to Globally
Sustainable Nuclear Energy Systems”

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IAEA, Vienna, Austria

Sustainable Nuclear Energy Systems Roadmap

Armenian Case

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IAEA

International Atomic Energy Agency

Presentation outline



1. Nuclear energy as part of a national energy mix
2. Nuclear energy scenario and strategy
3. Options for technological innovations and expansion of international cooperation for enhanced Nuclear Energy sustainability until the end of the century

Armenia Development Strategy (ADS) for 2014-2025

RA Government Decree # 442-N on 27th of March, 2014



ADS is based on the following four priorities:

- Priority 1. Growth of employment;
- Priority 2. Development of human capital;
- Priority 3. Improvement of social protection system; and
- Priority 4. Institutional modernization of the public administration and governance.

There are three sets of priority strategies:

- ***Economic policy for ensuring sustainable and accelerated economic growth;***
- Active social and income policy for vulnerable groups of population;
- Modernization of governance system.



Armenia Development Strategy (ADS) for 2014-2025

RA Government Decree # 442-N on 27th of March, 2014

11.4. ENERGY

11.4.2 MAIN DIRECTIONS OF PROGRAM POLICIES

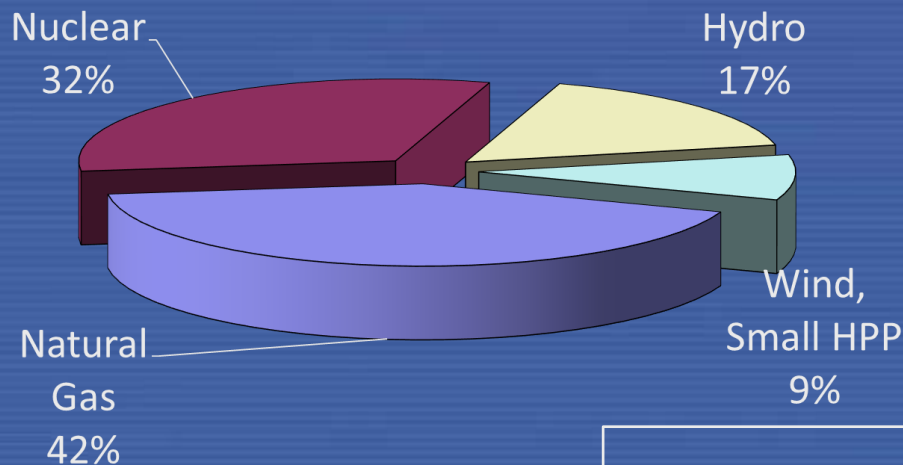
315. ... the main directions of the policy implemented in this sector will be as follows:

- 1) maximum use of domestic energy sources, specially renewables;
- 2) further development of nuclear energy, in particular **construction of new energy unit**, enhance in security of Armenian NPP 2nd unit and extension of its utilization period;
- 3) replacement of physically and morally depreciated power plants with those furnished with new technologies;
- 4) diversification of energy supplies and regional integration;
- 5) promotion of energy efficiency in all sectors using energy resources;
- 6) Increase of the level of safety and reliability of the power system.

317. The new nuclear power plant with 1000 MW capacity (which is already provided for by the RA Law) will require an investment of USD 4-5 billion.

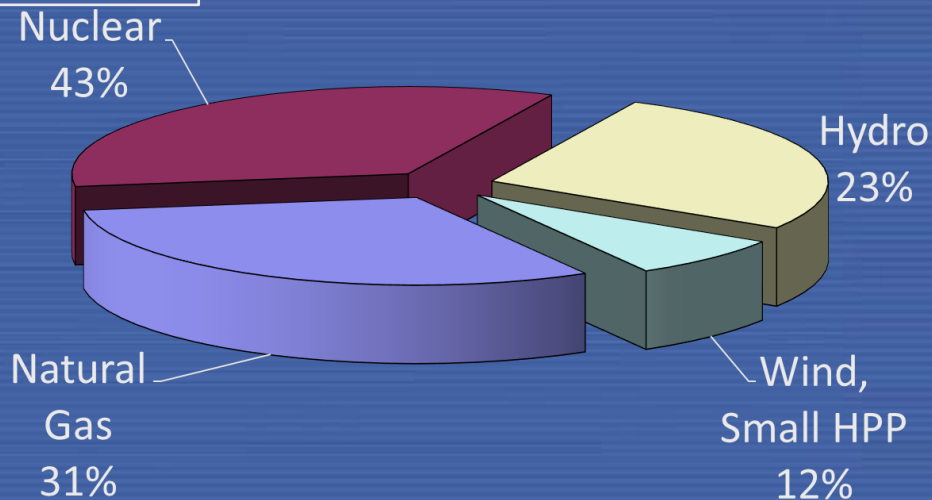
Armenian Power System: Main Indicators (as of 31.12.2014)

Shares of electricity production



Total generation mix

Generation for domestic use



Domestic Energy Sources: Renewables only

TOTAL New: 714 MW, ~2480 million kWh/year

- ✓ Solar PV: 40 MW, 58 million kWh/year up to 2020
 30 MW, 48 million kWh up to 2038
- ✓ Small HPPs: 148 MW, 495 million kWh up to 2021
- ✓ Wind Farms: 150 MW, 395 million kWh up to 2027
 50 MW, 85 million kWh up to 2040
- ✓ Shnokh HPP: 70 MW, 270 million kWh in 2021
- ✓ Loriberd HPP: 66 MW, 212 million kWh in 2021
- ✓ Meghri HPP: 130 MW, 720 million kWh in 2032
- ✓ Geothermal PP: 30 MW, 194 million kWh in 2021

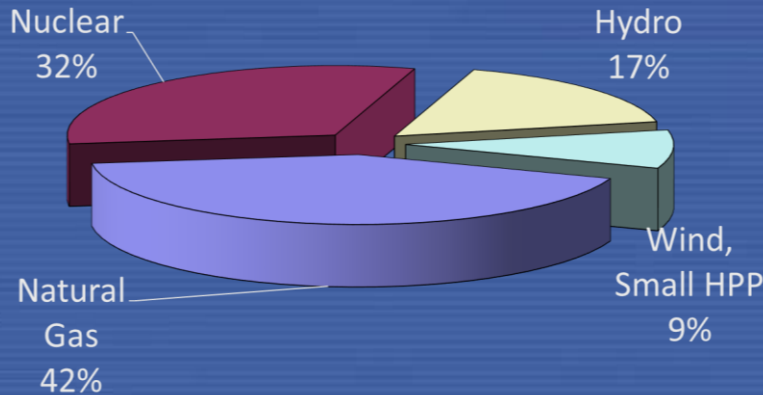
TOTAL Existing: 1188 MW, ~2000 million kWh

Grand TOTAL: 1902 MW, ~4480 million kWh

**In 2014 total final electricity consumption was
6142 million kWh**

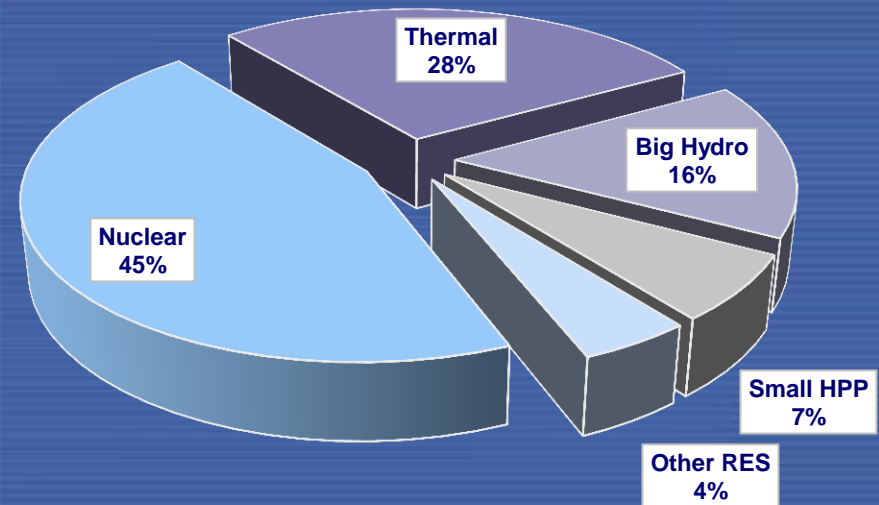
Armenia Least-cost Energy Development Plan (Feb. 2015)

Electricity Generation: 2014



“Long-term (up to 2036) Development Pathways of Armenian Energy System”

Electricity Generation: 2036



Technology (2036)	Capacity, MW
Nuclear	1028
Thermal	1280
Big Hydro	1216
Small HPP	370
Other RES	253
TOTAL:	3527

Electricity Generation Structure up to 2100

INPRO CP SYNERGY



Generation Structure, million kWh

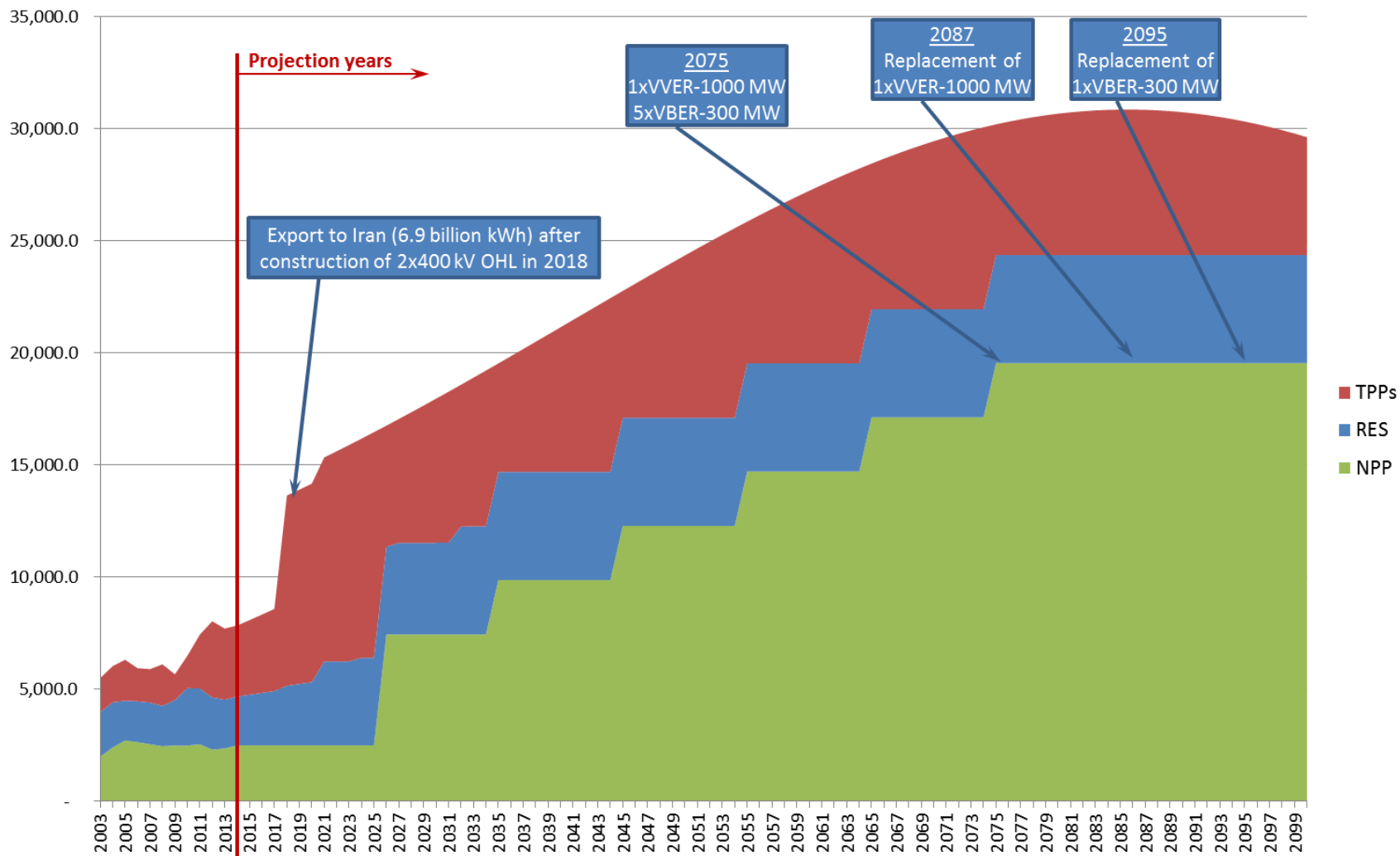


Table 1a: National prospects for nuclear energy size and growth until the end of the century



Please, indicate your country: Armenia		Time frames			
Is the information provided (a) an official plan or (b) a scenario study or expert opinion		Current	2016-2035 (a)	2036-2055 (b)	2056-2100 (b)
Nuclear energy growth taking into account decommissioning	Decreasing				
	Stabilization including replacement of units	X	New 600-1000 MW unit in 2027		
	Small growth (below 0.1 GWe/year)		X	X	X
	Medium growth (between 0.1 and 0.5 GWe/year)		3xVBER-300		
Nuclear energy size	Significant growth (>0.5 GWe/year)		2xVBER-300 & Replacement: 1x1000 MW + 1x300 MW		
	No nuclear				
	Small (0-10 GWe)	X	X	X	X
	Medium (10-50 GWe)				
	Large(>50 GWe)		2625 MW in 2075 (INPRO CP SYNERGY)		

Table 1b: National prospects for NES collaboration strategy until the end of the century



Please, indicate your country: Armenia		Time frames				
		Current	2016-2035	2036-2055	2056-2100	
Is the information provided (a) an official plan or (b) a scenario study or expert opinion			(a)	(b)	(b)	
NES Collaboration strategy	NES Function	Reliance on (1) National indigenous technology development, (2) International cooperation: single bi-lateral agreement, (3) International cooperation: multi-lateral agreement, (4) International cooperation: multiple bi-lateral agreements/ multiple suppliers providing for a competitive choice of the supplier/customer ¹				
	Obtain/produce Uranium		Collaboration with technology holder/supplier			
	Convert/enrich uranium					
	Fabricate obtain fuel	(2)	(2)	(2)	(4)	
	Produce Energy	NPP design		Collaboration with multiple suppliers		
		NPP operation	(1)	(1)	(1)	(1)
	Store SNF	(2)	(2)	(2)	(3)	
	Reprocess SNF				(2)	
	Dispose HLW/SNF				(2)	

SNF dry storages construction supported by FRAMATOM
SNF stored according to “TN International NUHOMS 56V technology”

Armenia will be ready for multi-lateral cooperation for SNF storage

Technology options of interest to enhance Nuclear Energy sustainability



Please, indicate your country: Armenia		Armenia			
Group	Option	Time frames			
		Current	2016-2035	2036-2055	2056-2100
Technology	A Base nuclear energy option	X	X	X	X
	B Safe disposal of spent nuclear fuel	X	X	X	X
	C Higher reactor outlet temperatures to open new energy markets				X
	D Once-through breed and burn				
	E Limited recycling of used nuclear fuel to reduce waste				
	F Fast breeder reactors ($BR \geq 1$) and a closed fuel cycle				
	G Minor actinide transmutation				
	H Thorium-based closed fuel cycle				

Possibly, in the second half of the century Armenia will discuss and introduce a high temperature reactor for hydrogen production to be used in transport sector.



Thank you